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A COMPARISON OF POINT LOAD INDEX AND LABORATORY DERIVED ROCK PROPERTY DATA FROM THE LINGAN MINE, SYDNEY COALFIELD, N.S.

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July 1987

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36pp

COAL RESEARCH LABORATORIES
DIVISION REPORT CRL 87-70(TR)

MICROMEDIA

A COMPARISON OF POINT LOAD INDEX AND LABORATORY DERIVED ROCK PROPERTY DATA FROM THE LINGAN MINE, SYDNEY COALFIELD, N.S.

by

T.R.C. Aston*

SUMMARY

The report presents a comparison of point load index and laboratory derived uniaxial compressive and tensile rock strength values obtained from five in situ stress determination boreholes drilled in the 7 West materials road at Lingan Mine, Sydney Coalfield, N.S.

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COMPARAISON ENTRE L'INDICE DE CHARGE PONCTUELLE ET LES DONNÉES DE LABORATOIRE SUR LA PROPRIÉTÉ DES ROCHES DE LA MINE LINGAN DU GÎTE DE SYDNEY EN N.-É.

par

T.R.C. Aston*

RÉSUMÉ

Le présent rapport présente les résultats d'une comparaison effectuée entre les données d'indice de charge ponctuelle et les valeurs uniaxiales de résistance à la compression et à la traction uniaxiales provenant d'essais en laboratoire obtenues à partir de cinq trous de sonde forés pour déterminer la contrainte in situ dans la voie de roulage pour matériaux 7 Ouest de la mine Lingan du gîte de Sydney en N.-É.

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INTRODUCTION

Between January 16 and February 21, 1986 a program of in situ stress determinations using both overcoring and minifracturing techniques was undertaken at the Lingan Mine, Sydney Coalfield (1). Five 100 mm diameter boreholes were drilled for the program, which produced a total of 110.3 m of 'HQ' size core. Apart from samples required for the overcore testing program, selected samples were also sent to the CANMET Mining Research Laboratories in Ottawa for uniaxial compressive, tensile and triaxial testing (2,3).

In August 1986, a program of point load index testing was carried out on the remaining core, as part of the establishment of a Sydney Coalfield geotechnical data base. The purpose of this report is to present the results obtained from the point load testing program and compare the values with those obtained from the laboratory test program.

TEST SITE AND GEOLOGY

The test site was located 62.5 m along the 7 West top level at a depth of 590 m, Figure 1. The level was supported using 3.7 m high by 5.2 m wide arches with the floor coinciding with the base of the Harbour Seam, which at this location was approximately 1.8 m thick with a dip of 13% to the north.

A summary of the borehole dimensions and orientations along with information relevant to the USBM overcoring tests is given in Table 1.

Geologically, strata above and below the Harbour Seam consists of an interbedded sequence of mudstones, siltstones, sandstones and thin coal seams. The dominant structural fabric of the strata is bedding, although some bedding plane fractures and intraformation shears in the mudstone horizon were also seen. Shear planes were particularly evident in a 0.3 m thick band of muddy siltstone located immediately above the coal seam. Two main sets of shear planes were observed with dips and dip directions of 38°/274° and 50°/102°.

In general, the sandstones were medium to coarsely grained with some carbonaceous bands. The siltstones and finely grained sandstones also

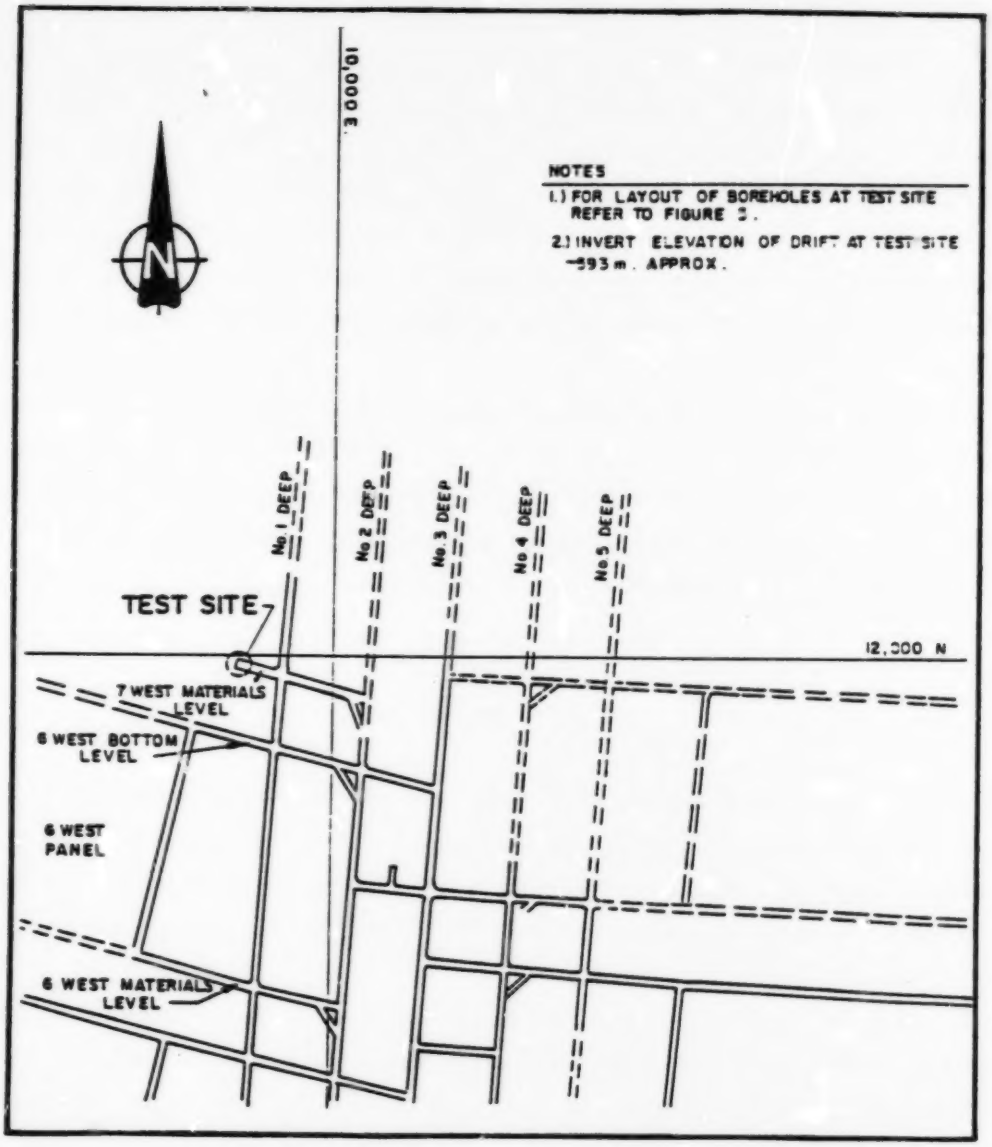

Figure 1 - Location of test site, Lingan Mine

BOREHOLE NO.	BOREHOLE ORIENTATION				TEST NO.	ROCK TYPE	DEPTH OF TEST FROM COLLAR(m)	COMMENT ON TEST
	AZIMUTH	DIP	COLLAR ELEVATION (m)	TOTAL DEPTH (m)				
L1	330°	27°	-591.36	30.4	L101	Siltstone	8.81	c
					L102	Siltstone	9.51	a, d
					L103	Siltstone	10.19	a, d
L2	330°	6°	-592.00	13.6	L201	Siltstone	10.36	b
					L202	Siltstone	11.96	b
					L203	Siltstone	12.50	a, e
					L204	Siltstone	13.26	a, d
L3	272°	12°	-591.72	11.7	L301	Siltstone	9.65	a, d
					L302	Siltstone	10.21	c
					L303	Siltstone	11.20	a, d
L4	--	-90°	-593.72	31.6	--		--	No USBM Tests
L5	--	-90°	-593.47	25.3	L501	Siltstone	12.80	a, e

1. COMMENTS ON TESTS

   a. Test successful.
   b. Test aborted as USBM gauge was loose in pilot hole.
   c. Rock broke close to USBM gauge buttons during test.
   d. Intact overcore sample recovered from test suitable for Biaxial Testing.
   e. Overcore sample broke during recovery.

2. NOTES:
   Azimuth is referenced to north.

Table 1 - Summary of borehole dimensions and orientations, Lingan 7W material level test site

had some locally occurring thin carbonaceous bands parallel to the bedding. The mudstones were thinly bedded and occasionally laminated. The coal had frequent joints and a well developed cleat '1).

Geological logs of the boreholes are given in Appendix A.

POINT LOAD INDEX TESTING

The point load index testing apparatus is shown in Figure 2 and its operation fully described in the Pit Slope Manual (4).

Essentially, the test involves loading a sample of known shape and size between two points, Figure 3. Extensive work (4,5,6) has reported factors affecting the test and proposed the method as a valid means of determining a rock strength index.

The point load index, I, is derived using Equation 1:

$$I = P/D^2 \qquad \text{Eq 1}$$

where, P = Point Load (kPa)
D = Diameter of the Specimen (mm)

In the case of irregular specimen testing, the samples should be roughly spheroidal in shape with a preferred diameter of 50 mm. However, maximum and minimum diameters of 100 mm and 25 mm are acceptable (4). The acceptable ratio of the longest to shortest diameter of the specimen falls between 1.0 and 1.4, Figure 3.

TEST PROGRAM

Initially, the borehole logs were examined and potential test horizons identified. The primary object being to obtain results representative of each of the three main rock types encountered: sandstone, siltstone and mudstone. The actual core was then examined to ensure that the potential horizon identified contained: 1) samples with a length/diameter ratio of at

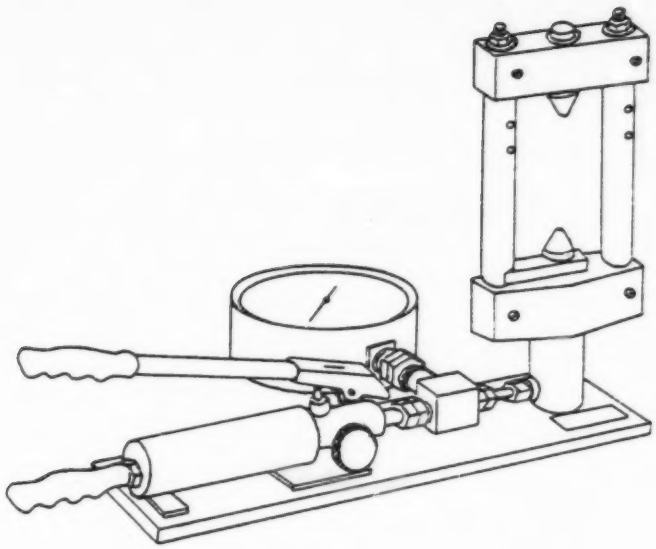

Figure 2 - Point load test apparatus
(manufactured by ELE Ltd., U.K.)(4)

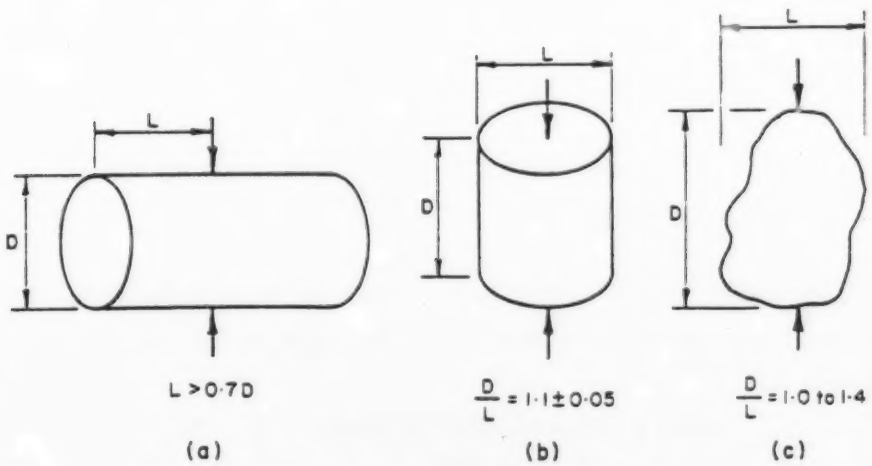

Figure 3 - Types of point load strength tests (4)

least 1·4 and 2) sufficient samples existed within the unit to produce a realistic mean index value.

It should be noted, that testing was conducted on samples chosen from pre-determined geological units. However, the location of the sample within the unit, relative to the borehole collar, was not recorded.

TEST RESULTS

The diameter of the test specimen can exert a significant influence on the derived index value, even though the length/diameter criteria are maintained (4,5,6). It is therefore important to standardize the reporting of index data according to specimen diameter.

The Pit Slope Manual (4) gives a size correction chart for calculating the Is_{54} value from a reference diameter of 50 mm. However, an extensive study by Hassani et al. (6) has shown that mathematical equations can be derived which represent the correction curves and therefore avoid the problems associated with distortion and inadequate reproduction of the original chart.

Index values can be corrected to an equivalent of 54 mm (standard 'NX' size core) using Equation 2 (6):

$$\text{Log}_{10}Is_{54} = 0.229 + \text{Log}_{10}I - 1.008e^{-0.0274(D)} \qquad \text{Eq 2}$$

where, I = Index Strength (kPa)
D = Specimen Diameter (mm)

The relationship between the point load index strength, uniaxial compressive and tensile strength has also been reported as follows (6):

Uniaxial Compressive Strength

$$\sigma_c = 29.24\ Is_{54} \qquad \text{Eq 3}$$

Tensile Strength Eq 4

$$Ts = 2.78\ Is_{54}$$

To simplify the calculation of both actual and corrected point load indices as well as the uniaxial compressive and tensile strength of the samples, a computer program 'POINT LOAD INDEX' was developed (7). The program uses Equations 1,2,3 and 4 and was developed for use on an IBM-PC/AT microcomputer using the BASIC-A Version 3.10 language.

Results from the various strata horizons tested were processed using the 'POINT LOAD INDEX' program and are given in Appendix B.

DISCUSSION

Figures 4 to 8 show the geological logs of the five boreholes along with the mean Is_{50} and point load derived (PLD) uniaxial compressive and tensile strength values. Also plotted on the same diagrams are the available laboratory test results (2,3).

Unfortunately, no laboratory test results were obtained from any of the strata units tested with the point load method. This can be attributed to: 1) a lack of specimens with a length/diameter ratio of 1•4 and/or 2) an insufficient number of samples to produce a representative mean value.

In Figure 4, Lingan L-1 borehole, two laboratory derived tensile strength values from a siltstone unit at 8.2 to 13.4 m can be compared against the mean PLD tensile strength values of a siltstone unit at 0.0 to 7.4 m. The mean laboratory tensile strength is 7.1 MPa, while the mean PLD tensile stength is 9.2 MPa. The results could therefore be interpreted as suggesting that the two siltstone units are lithologically similar with comparable geotechnical properties. However, a comparison of the laboratory and PLD uniaxial compressive strength values for the same two siltstone units shows that the mean compressive strength of the 0.0 to 7.4 m unit (97 MPa) is much greater than the 8.2 to 13.4 m unit (40 MPa). The variation between the uniaxial compressive strength values can be attributed to: 1) differences in the lithological structure of the two siltstone units and/or 2) an inherent error, representative of the differences in test procedures between the laboratory and point load methods.

In boreholes L-2 and L-3, Figures 5 and 6, laboratory values were derived for the uniaxial compressive strength of siltstone and mudstone samples both parallel and perpendicular to the bedding plane (2). In both

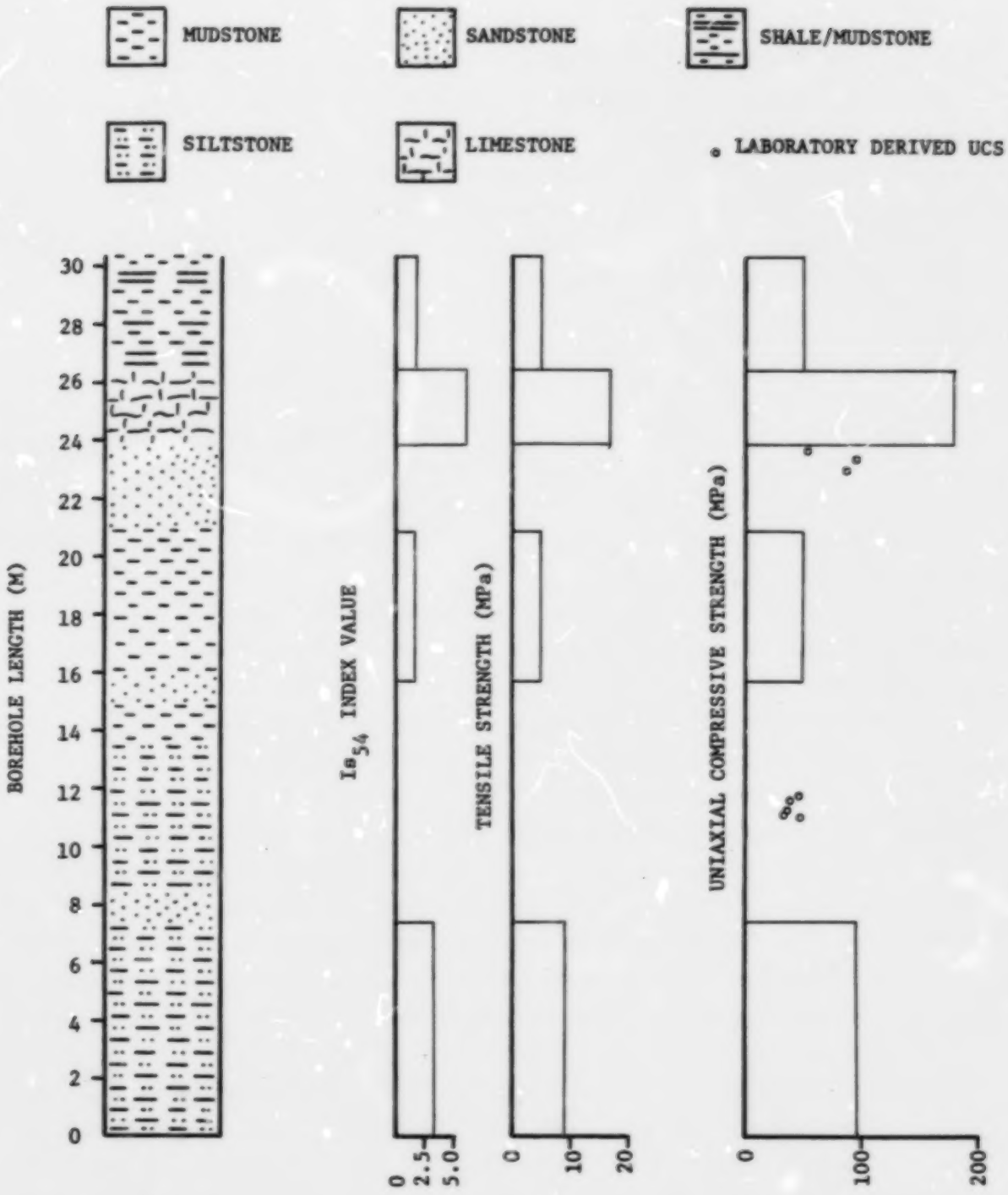

Figure 4 - Core log and rock property data, Lingan L-1 borehole

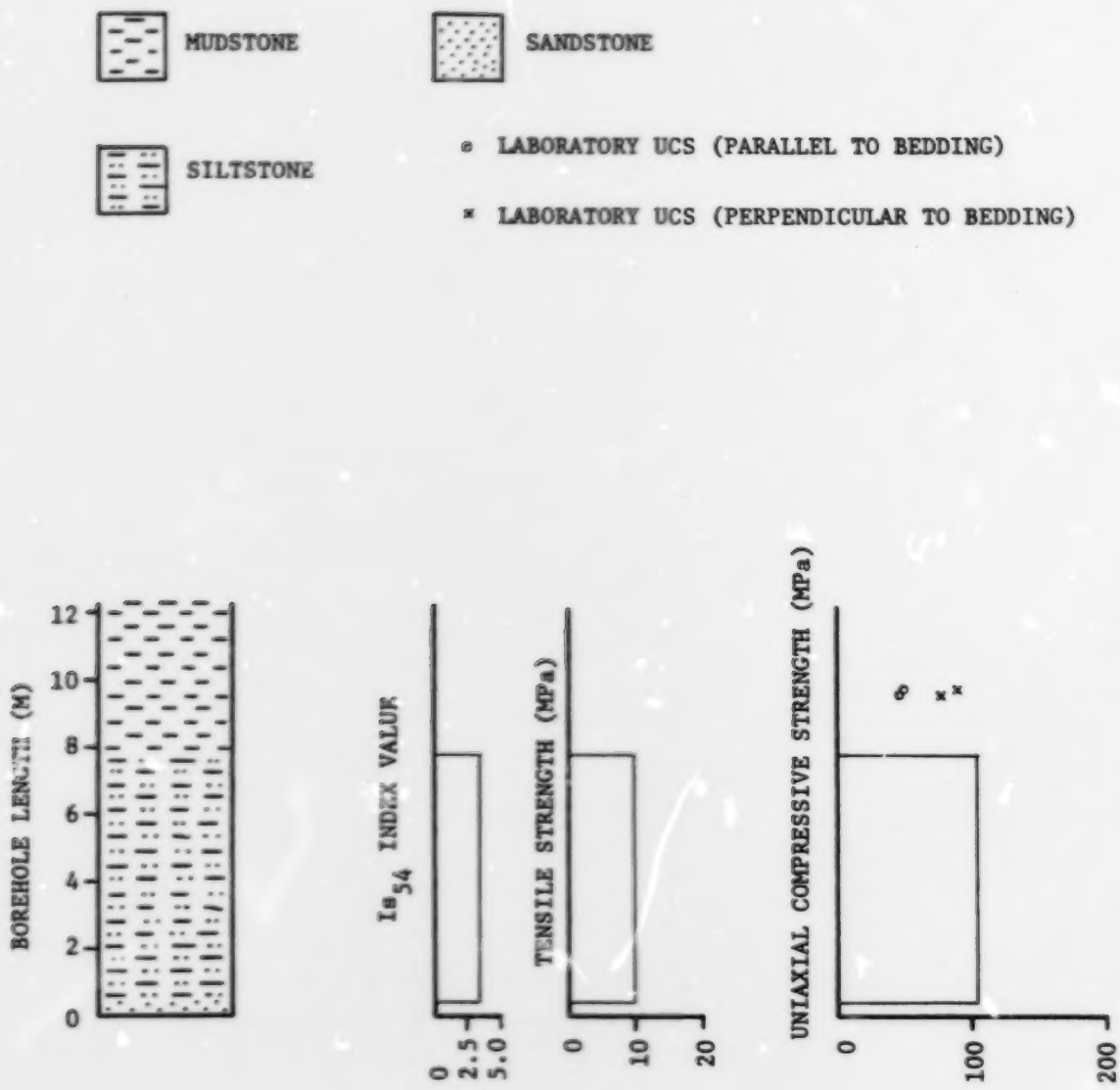

Figure 5 - Core log and rock property data, Lingan L-2 borehole

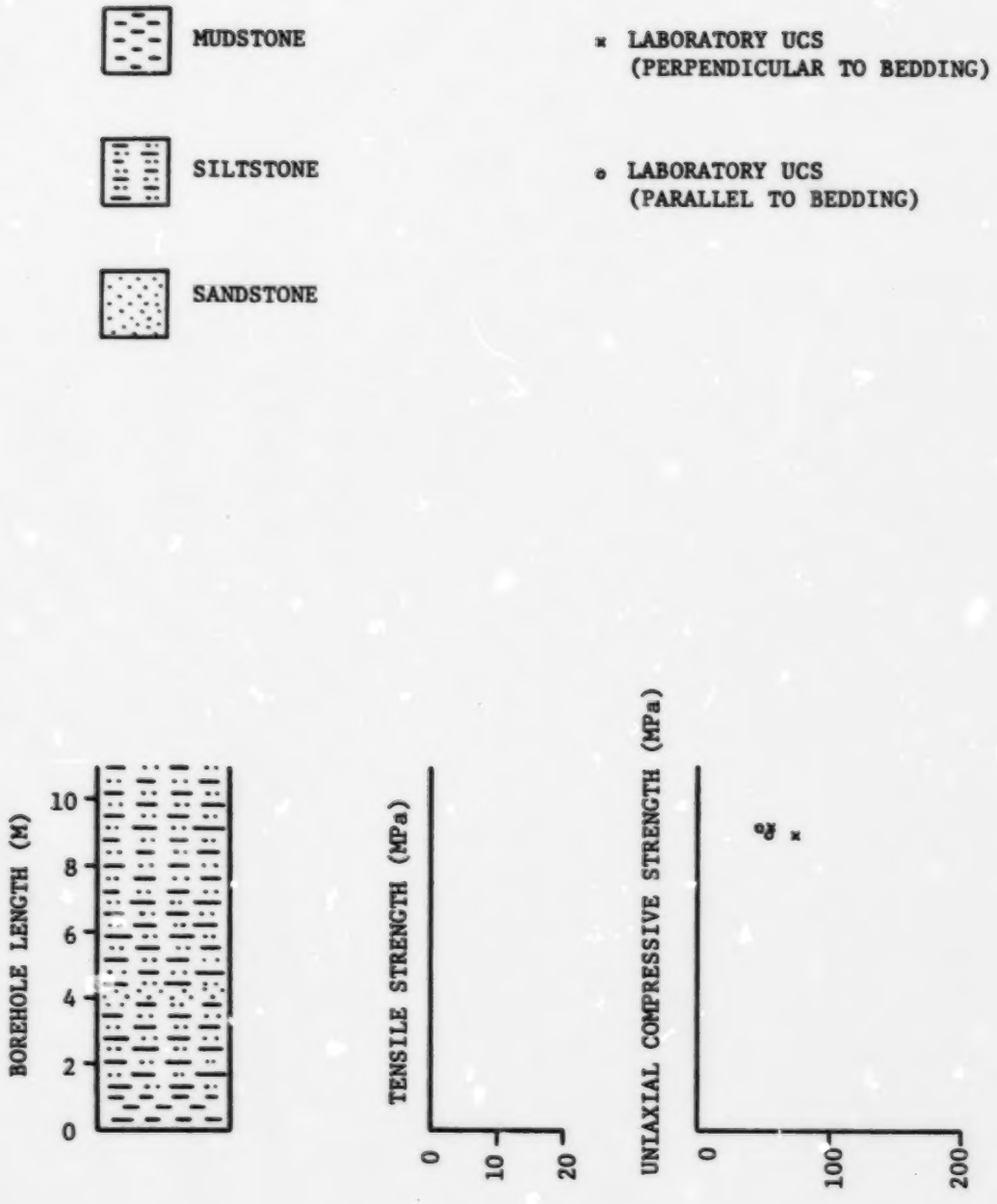

Figure 6 - Core log and rock property data, Lingan L-3 borehole

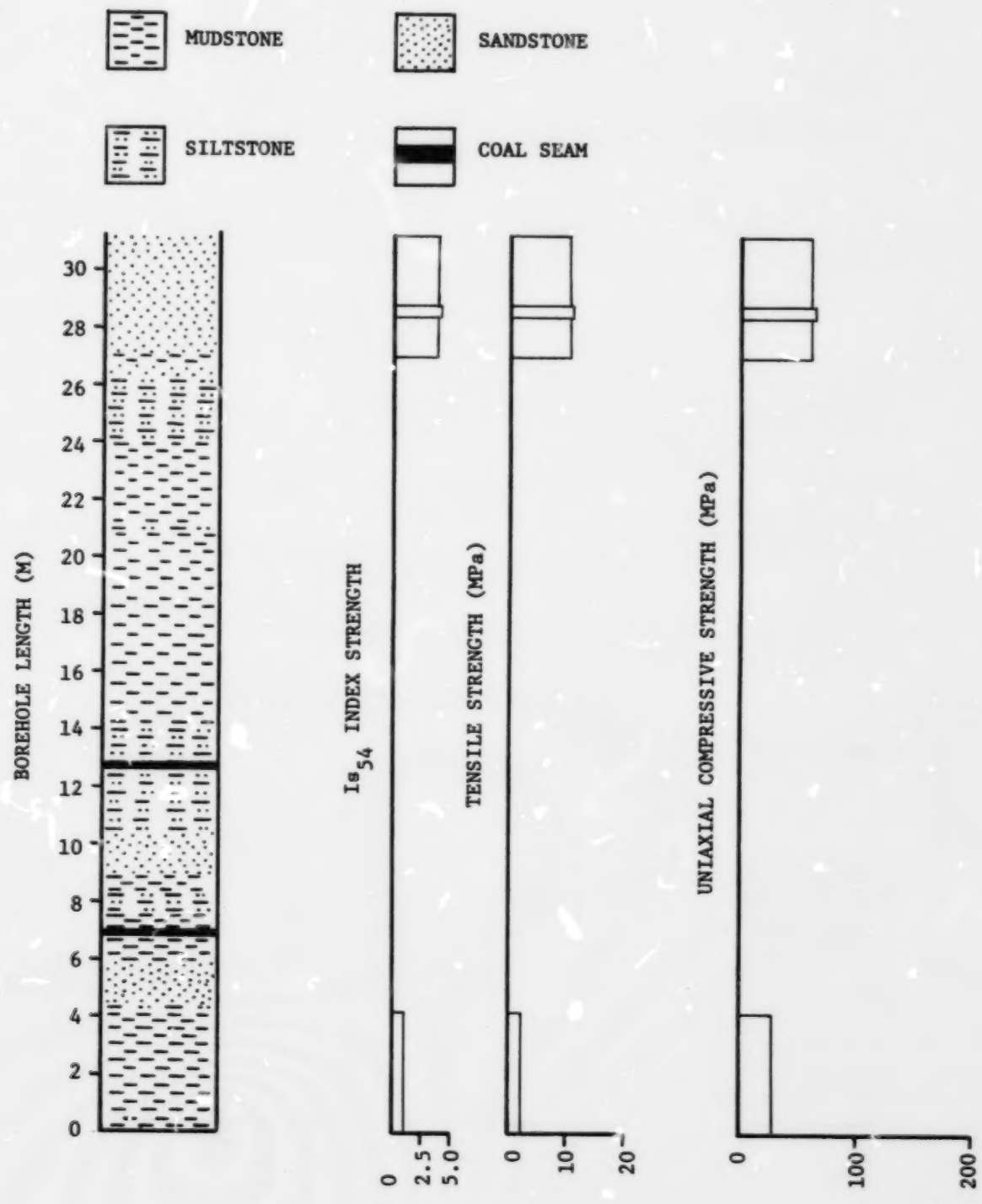

Figure 7 - Core log and rock property data, Lingan L-4 borehole

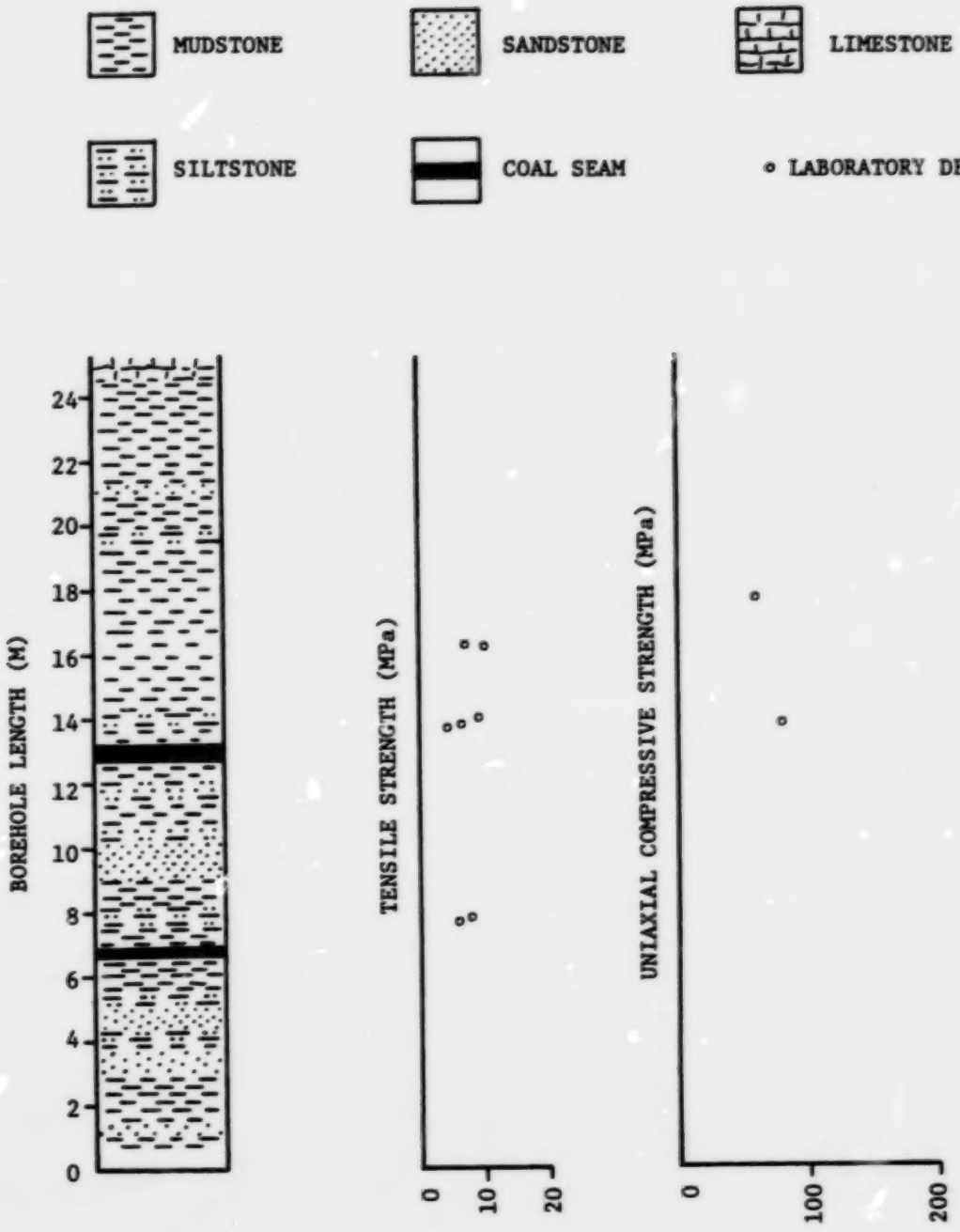

Figure 8 - Core log and rock property data, Lingan L-5 borehole

cases, the uniaxial compressive strength values were greater perpendicular rather than parallel to the bedding plane.

CONCLUSION

An analysis of the laboratory and point load derived rock strength data from the Lingan in situ stress test site cannot be made due to a lack of directly comparable data. Laboratory derived values of tensile and uniaxial compressive strength are normally accepted as being accurate, providing the standard testing procedures are adhered to. However, in the case of point load derived tensile and uniaxial compressive strength values, considerable uncertainty exists regarding their accuracy and they should therefore only be viewed as a 'good first order approximation' of the actual rock strength.

A limited program of laboratory testing indicates that a difference exists between the uniaxial compressive strength parallel and perpendicular to the strata bedding plane at the Lingan 7 West top level in situ stress test site.

Further research is therefore recommended to: 1) examine the reliability of point load testing for the determination of tensile and uniaxial compressive strength values in the Sydney Coalfield and 2) investigate the relationship between the geotechnical properties of the strata parallel and perpendicular to the bedding plane.

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APPENDIX A

HOLE NO. L-1

DEPTH (m)	DESCRIPTION
0 - 7.44	SILTSTONE - medium grey; fine to medium grained; numerous fossiliferous pods; laminated wispy sandy sections throughout; crossbedded in places; micaceous; ironstone staining; carbonaceous partings; gradational contact; competent.
7.44 - 8.23	SANDSTONE - light to medium grey; fine grained; contains 30% laminated siltstone; entire unit is highly laminated; abundant carbonaceous material; gradational contact; competent.
8.23 - 13.41 (NOTE: 9.45 - 10.85 is missing)	SILTSTONE - medium grey; fine grained; micaceous; slightly fossiliferous; slightly cross bedded; a few small (wispy) beds of sandstone noted; gradational contact.
13.41 - 15.01	MUDSTONE - medium to dark grey; very silty; fossiliferous; slightly banded; erosive contact.
15.01 - 15.69	SANDSTONE - light to medium grey; fine grained; highly laminated; grades to a siltstone at base; slightly crossbedded; ironstone staining; gradational contact.
15.69 - 20.88	MUDSTONE - medium to dark grey; very silty in sections ($\leq$25%); highly broken 18.11 - 18.28; siltstone from 19.81 to 20.24; gradational contact.
20.88 - 23.87	SANDSTONE - light to medium grey; highly laminated; micaceous; gradational contact; competent.
23.87 - 26.51	LIMESTONE - brownish grey; sugary texture; massive; sharp contact; competent.
26.51 - 30.40	SHALE/MUDSTONE - medium to dary grey; very little silt; bedded; slightly fossiliferous.

END OF HOLE

HOLE NO. L-2

DEPTH (m)	DESCRIPTION
0 - 0.33	MUDSTONE - dark grey; very silty fossiliferous; gradational contact.
0.33 - 7.82	SILTSTONE - medium grey; fine to medium grained; numerous wispy sandstone bands; slightly fossiliferous; coal shards; micaceous; gradational contact; competent.
7.82 - 12.32	SANDSTONE - light to medium grey; fine grained; highly laminated (contains ≤ 30% siltstone); siltstone beds up to 15 cm thick throughout; micaceous carbonaceous; last 25 cm of unit is bordering on a coarse siltstone; competent.

END OF HOLE

HOLE NO. L-3

DEPTH (m)	DESCRIPTION
0 - 0.91	MUDSTONE - medium grey; very silty; no plant fossils noted; noncalcareous; non micaceous; slickensided surfaces noted; gradational contact.
0.91 - 4.04	SILTSTONE - medium grey; fine grained; massive; calcareous; fossiliferous; competent.
4.04 - 4.29	SANDSTONE - light to medium grey; fine grained; crossbedded; slightly carbonaceous; contact (see Diagram); competent.

discing in siltstone

4.29 - 10.99	SILTSTONE - medium grey; medium grained; numerous wispy sandstone bands throughout (last 30 cm is quite sandy); only a few plant fossils noted; micaceous; competent.

END OF HOLE

HOLE NO. L-4

DEPTH (m)	DESCRIPTION
0 - 4.27	MUDSTONE - medium to dary grey; first 15 cm is quite silty; highly fossiliferous; first 3 m is highly broken up along bedding; gradational contact.
4.27 - 4.37	SILTSTONE - medium grey; laminated; slightly crossbedded; micaceous; fossiliferous; gradational contact; competent.
4.37 - 5.76	SANDSTONE - light grey; fine to medium grained; micaceous; slightly crossbedded; carbonaceous beds; erossive contact; competent.
5.76 - 6.75	MUDSTONE - medium to dark grey; highly fossiliferous; slickensided surfaces throughout; weak.
6.75 - 6.96	COAL
6.96 - 7.59	MUDSTONE - medium grey; seatearth; silty; gradational contact; weak.
7.59 - 8.17	SILTSTONE - medium grey; slightly laminated; sandy sections; micaceous; erosive contact; competent.
8.17 - 8.92	MUDSTONE - medium to dark grey; silty; fossiliferous; erosive contact.
8.92 - 10.67	SANDSTONE - light grey; fine to medium grained; massive; micaceous; silty sections; discing noted; gradational contact; competent.
10.67 - 12.62	SILTSTONE - medium to dark grey; fossiliferous; micaceous; laminated; competent.
12.62 - 12.80	COAL
12.80 - 13.16	MUDSTONE - dark grey; seatearth; fossiliferous; weak.
13.16 - 13.99	SILTSTONE - medium grey; medium grained; micaceous; carbonaceous; sandy sections; gradational contact; competent.
13.99 - 20.55	MUDSTONE - medium to dark grey; quite silty; sandstone clasts; slightly laminated; micaceous where silty; erosive contact; competent.
20.55 - 20.93	LAMINITE (70% Siltstone/30% Sandstone) - light to medium grey; fine grained; micaceous; carbonaceous; erosive contact; competent.

DEPTH (m)	DESCRIPTION
20.93 - 24.08	MUDSTONE - medium to dark grey; somewhat silty; fossiliferous; gradational contact.
24.08 - 26.31	SILTSTONE - medium grey; fine grained; mudstone sections; fossiliferous; micaceous; erosive contact; competent.
26.31 - 26.77	SANDSTONE - medium grey; medium grained; highly calcareous; carbonaceous flecks; sharp contact; competent.
26.77 - 26.97	MUDSTONE - medium to dark grey; non fossiliferous; no noticeable grain; nonmicaceous; massive; sharp contact.
26.97 - 28.45	SANDSTONE - light grey; medium to coarse grained; calcareous; large flakes of mica and carbonaceous material along bedding; crossbedded; gradational contact; competent.
28.45 - 28.83	SANDSTONE - medium to dark grey; fine grained; micaceous; slightly laminated; noncalcareous; gradational contact; competent.
28.83 - 31.29	SANDSTONE - light grey; fine to medium grained; carbonaceous flecks; massive; competent.

END OF HOLE

HOLE NO. L-5

DEPTH (m)	DESCRIPTION
0 - 0.63	Not cored
0.63 - 1.11	MUDSTONE - medium grey; quite silty fossiliferous; sharp lower contact.
1.11 - 1.45	SANDSTONE - light to medium grey; fine to medium; first 12 cm is massive; remaining section is laminated (65% sandstone/35% siltstone); erosive lower contact; competent.
1.45 - 3.05	MUDSTONE - dark grey; slightly laminated; silty; fossiliferous; siltstone (1.49 - 1.70); calcareous shale section (2.20 - 2.44).
3.05 - 3.73	SANDSTONE - light to medium grey; first 10 cm is massive (fine to medium grained); remaining section contains interbeds of siltstone; micaceous; gradational lower contact; competent.
3.73 - 4.01	MUDSTONE - medium to dark grey; silty; fossiliferous; ironstone staining; slightly laminated; gradational contact.
4.01 - 4.21	SILTSTONE - medium grey; fine grained; micaceous; gradational contact; competent.
4.21 - 5.05	SANDSTONE - light to medium grey; medium grained; carbonaceous; large mica flakes; crossbedded; silty bands; gradational contact; competent.
5.05 - 5.49	SILTSTONE - medium grey; fine grained; micaceous; noncalcareous; gradational contact; competent.
5.49 - 6.63	MUDSTONE - medium to dark grey; laminated sections; highly fossiliferous.
6.63 - 6.93	COAL (6.40 - 7.01 m is spread over 0.91 m in the coal box, .'. Rider Seam thickness is an estimate.
6.93 - 7.39	MUDSTONE - seatearth; medium to dary grey; highly fossiliferous; very weak.
7.39 - 8.23	SILTSTONE - medium grey; fossiliferous; medium grained; micaceous; small sandy beds noted; gradational lower contact; competent.
8.23 - 9.04	MUDSTONE - dark grey; shaley; slightly laminated; numerous slickensided surfaces; erosive lower contact;

HOLE NO. L-5 (cont)

DEPTH (m)	DESCRIPTION
9.04 - 10.08	SANDSTONE - light grey; medium grained; carbonaceous; streaks; micaceous; silty toward base; gradational lower contact; slight core discing noted at 9.78 m (9.09 - 9.78 - missing core).
10.08 - 12.70	LAMINITE (80% mudstone/15% siltstone/5% sandstone) light to dark grey; wispy sandy beds throughout; fossiliferous; micaceous; sharp lower contact.
12.70 - 13.23	COAL (17.7 cms in core box)
13.23 - 13.59	MUDSTONE - seatearth; dark grey; slightly silty; gradational contact.
13.59 - 14.12	SILTSTONE - medium grey; very coarse grained; ironstone staining; micaceous; gradational lower contact; competent.
14.12 - 19.45	MUDSTONE - dark grey to black; numerous silty beds throughout; slightly micaceous where silty; noncalcareous; laminated appearance; fossiliferous; 5 cm sandstone bed at 19.15; gradational contact; competent.
19.45 - 19.78	SILTSTONE - medium grey; sandy sections; micaceous; noncalcareous; gradational contact; competent.
19.78 - 20.98	MUDSTONE - medium to dark grey; silty; non-fossiliferous; gradational lower contact; competent.
20.98 - 21.16	SANDSTONE - light grey; fine to medium grained; highly calcareous; micaceous; carbonaceous; erosive lower contact.
21.16 - 24.58	MUDSTONE - medium grey to black; very shaley in sections; fossiliferous; laminated appearance; calcareous shale at 24.56; sharp lower contact.
24.58 - 25.30	LIMESTONE - brownish grey; sugary texture; very impure.

END OF HOLE

APPENDIX B

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 1

DATE:AUG 6 1986 # OF TESTS: 12 FILE NAME:L1T1A

SAMPLE DESCRIPTION: SILTSTONE (0.0 - 7.44)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	16.000	4.03	4.52	12.56	132.14
2	63.00	11.400	2.87	3.22	8.95	94.15
3	63.00	12.000	3.02	3.39	9.42	99.10
4	63.00	13.200	3.33	3.73	10.36	109.02
5	63.00	10.100	2.54	2.85	7.93	83.41
6	63.00	9.000	2.27	2.54	7.07	74.33
7	63.00	12.000	3.02	3.39	9.42	99.10
8	63.00	7.200	1.81	2.03	5.65	59.46
9	63.00	11.600	2.92	3.28	9.11	95.80
10	63.00	7.300	1.84	2.06	5.73	60.29
11	63.00	15.100	3.80	4.26	11.86	124.71
12	63.00	13.300	3.35	3.76	10.44	109.84

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 11.517
MEAN Is = 2.90
MEAN Is 54 = 3.25
MEAN TS = 9.04
MEAN UCS = 95.11

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 1

DATE:AUG 6 1986 # OF TESTS: 11 FILE NAME:L1T2A

SAMPLE DESCRIPTION: MUDSTONE (15.69 - 20.88)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	7.800	1.97	2.20	6.12	64.42
2	63.00	5.400	1.36	1.53	4.24	44.60
3	63.00	13.300	3.35	3.76	10.44	109.84
4	63.00	6.000	1.51	1.69	4.71	49.55
5	63.00	2.900	0.73	0.82	2.28	23.95
6	63.00	3.600	0.91	1.02	2.83	29.73
7	63.00	2.900	0.73	0.82	2.28	23.95
8	63.00	3.200	0.81	0.90	2.51	26.43
9	63.00	9.000	2.27	2.54	7.07	74.33
10	63.00	8.400	2.12	2.37	6.60	69.37
11	63.00	4.000	1.01	1.13	3.14	33.03

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 6.045
MEAN Is = 1.52
MEAN Is 54 = 1.71
MEAN TS = 4.75
MEAN UCS = 49.93

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 1

DATE:AUG 6 1986 # OF TESTS: 9 FILE NAME:L1T3A

SAMPLE DESCRIPTION: LIMESTONE (23.87 -26.51)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	29.200	7.36	8.25	22.93	241.15
2	63.00	20.000	5.04	5.65	15.70	165.17
3	63.00	21.000	5.29	5.93	16.49	173.43
4	63.00	14.000	3.53	3.95	10.99	115.62
5	63.00	21.000	5.29	5.93	16.49	173.43
6	63.00	22.000	5.54	6.21	17.27	181.69
7	63.00	6.100	1.54	1.72	4.79	50.38
8	63.00	31.000	7.81	8.76	24.34	256.02
9	63.00	27.000	6.80	7.63	21.20	222.99

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 21.256
MEAN Is = 5.36
MEAN Is 54 = 6.00
MEAN TS = 16.69
MEAN UCS = 175.54

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 1

DATE:AUG 6 1986 # OF TESTS: 10 FILE NAME:L1T4A

SAMPLE DESCRIPTION: MUDSTONE (26.51 -30.40)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	7.500	1.89	2.12	5.89	61.94
2	63.00	8.000	2.02	2.26	6.28	66.07
3	63.00	7.000	1.76	1.98	5.50	57.81
4	63.00	10.000	2.52	2.82	7.85	82.59
5	63.00	6.000	1.51	1.69	4.71	49.55
6	63.00	4.600	1.16	1.30	3.61	37.99
7	63.00	5.100	1.28	1.44	4.00	42.12
8	63.00	6.200	1.56	1.75	4.87	51.20
9	63.00	5.000	1.26	1.41	3.93	41.29
10	63.00	2.400	0.60	0.68	1.88	19.82

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 6.180
MEAN Is = 1.56
MEAN Is 54 = 1.75
MEAN TS = 4.85
MEAN UCS = 51.04

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 2

DATE:AUG 6 1986 # OF TESTS: 8 FILE NAME:L2T1A

SAMPLE DESCRIPTION: SILTSTONE (0.33 - 7.82)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	17.000	4.28	4.80	13.35	140.40
2	63.00	9.000	2.27	2.54	7.07	74.33
3	63.00	13.400	3.38	3.78	10.52	110.67
4	63.00	15.200	3.83	4.29	11.94	125.53
5	63.00	13.100	3.30	3.70	10.29	108.19
6	63.00	14.700	3.70	4.15	11.54	121.40
7	63.00	10.400	2.62	2.94	8.17	85.89
8	63.00	7.800	1.97	2.20	6.12	64.42

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 12.575
MEAN Is = 3.17
MEAN Is 54 = 3.55
MEAN TS = 9.87
MEAN UCS = 103.85

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 4

DATE:AUG 7 1986 # OF TESTS: 10 FILE NAME:L4T1A

SAMPLE DESCRIPTION: MUDSTONE (0.0 - 4.27)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	5.400	1.36	1.53	4.24	44.60
2	63.00	2.900	0.73	0.82	2.28	23.95
3	63.00	3.500	0.88	0.99	2.75	28.91
4	63.00	2.400	0.60	0.68	1.88	19.82
5	63.00	1.600	0.40	0.45	1.26	13.21
6	63.00	3.000	0.76	0.85	2.36	24.78
7	63.00	3.500	0.88	0.99	2.75	28.91
8	63.00	5.500	1.39	1.55	4.32	45.42
9	63.00	2.200	0.55	0.62	1.73	18.17
10	63.00	2.600	0.66	0.73	2.04	21.47

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 3.260
MEAN Is = 0.82
MEAN Is 54 = 0.92
MEAN TS = 2.56
MEAN UCS = 26.92

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 4

DATE:AUG 7 1986 # OF TESTS: 11 FILE NAME:L4T2A

SAMPLE DESCRIPTION: SANDSTONE (26.97 - 31.29)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	17.500	4.41	4.94	13.74	144.53
2	63.00	10.000	2.52	2.82	7.85	82.59
3	63.00	15.000	3.78	4.24	11.78	123.88
4	63.00	11.500	2.90	3.25	9.03	94.98
5	63.00	14.000	3.53	3.95	10.99	115.62
6	63.00	10.000	2.52	2.82	7.85	82.59
7	63.00	17.000	4.28	4.80	13.35	140.40
8	63.00	15.500	3.91	4.38	12.17	128.01
9	63.00	11.000	2.77	3.11	8.64	90.85
10	63.00	16.000	4.03	4.52	12.56	132.14
11	63.00	11.000	2.77	3.11	8.64	90.85

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 13.500
MEAN Is = 3.40
MEAN Is 54 = 3.81
MEAN TS = 10.60
MEAN UCS = 111.49

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 4

DATE:AUG 7 1986 # OF TESTS: 12 FILE NAME:L4T3A

SAMPLE DESCRIPTION: SANDSTONE (26.97 - 31.23)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	12.500	3.15	3.53	9.82	103.23
2	63.00	11.000	2.77	3.11	8.64	90.85
3	63.00	11.000	2.77	3.11	8.64	90.85
4	63.00	13.000	3.28	3.67	10.21	107.36
5	63.00	12.000	3.02	3.39	9.42	99.10
6	63.00	14.000	3.53	3.95	10.99	115.62
7	63.00	24.000	6.05	6.78	18.84	198.21
8	63.00	13.000	3.28	3.67	10.21	107.36
9	63.00	17.000	4.28	4.80	13.35	140.40
10	63.00	11.500	2.90	3.25	9.03	94.98
11	63.00	12.500	3.15	3.53	9.82	103.23
12	63.00	13.500	3.40	3.81	10.60	111.49

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 13.750
MEAN Is = 3.46
MEAN Is 54 = 3.88
MEAN TS = 10.80
MEAN UCS = 113.56

CAPE BRETON COAL RESEARCH LABORATORY

LOCATION: LINGAN BH 4

DATE:AUG 7 1986 # OF TESTS: 10 FILE NAME:L4T4A

SAMPLE DESCRIPTION: SANDSTONE (26.97 - 31.23)

POINT #	SPECIMEN DIAMETER mm	LOAD KN	Is MPa	Is54 MPa	TENSILE STRENGTH MPa	UNIAXIAL COMPRESSIVE STRENGTH(MPa)
1	63.00	23.000	5.79	6.50	18.06	189.95
2	63.00	11.500	2.90	3.25	9.03	94.98
3	63.00	13.500	3.40	3.81	10.60	111.49
4	63.00	14.000	3.53	3.95	10.99	115.62
5	63.00	14.000	3.53	3.95	10.99	115.62
6	63.00	10.000	2.52	2.82	7.85	82.59
7	63.00	12.000	3.02	3.39	9.42	99.10
8	63.00	13.000	3.28	3.67	10.21	107.36
9	63.00	10.000	2.52	2.82	7.85	82.59
10	63.00	12.500	3.15	3.53	9.82	103.23

MEAN VALUES

MEAN SPECIMEN DIAMETER = 63
MEAN LOAD = 13.350
MEAN Is = 3.36
MEAN Is 54 = 3.77
MEAN TS = 10.48
MEAN UCS = 110.25